CHEMICAL & ENGINEERING NEWS

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FEBRUARY 7, 1994

FINAL PROGRAM -- ACS NATIONAL MEETING IN SAN DIEGO PAGE 29

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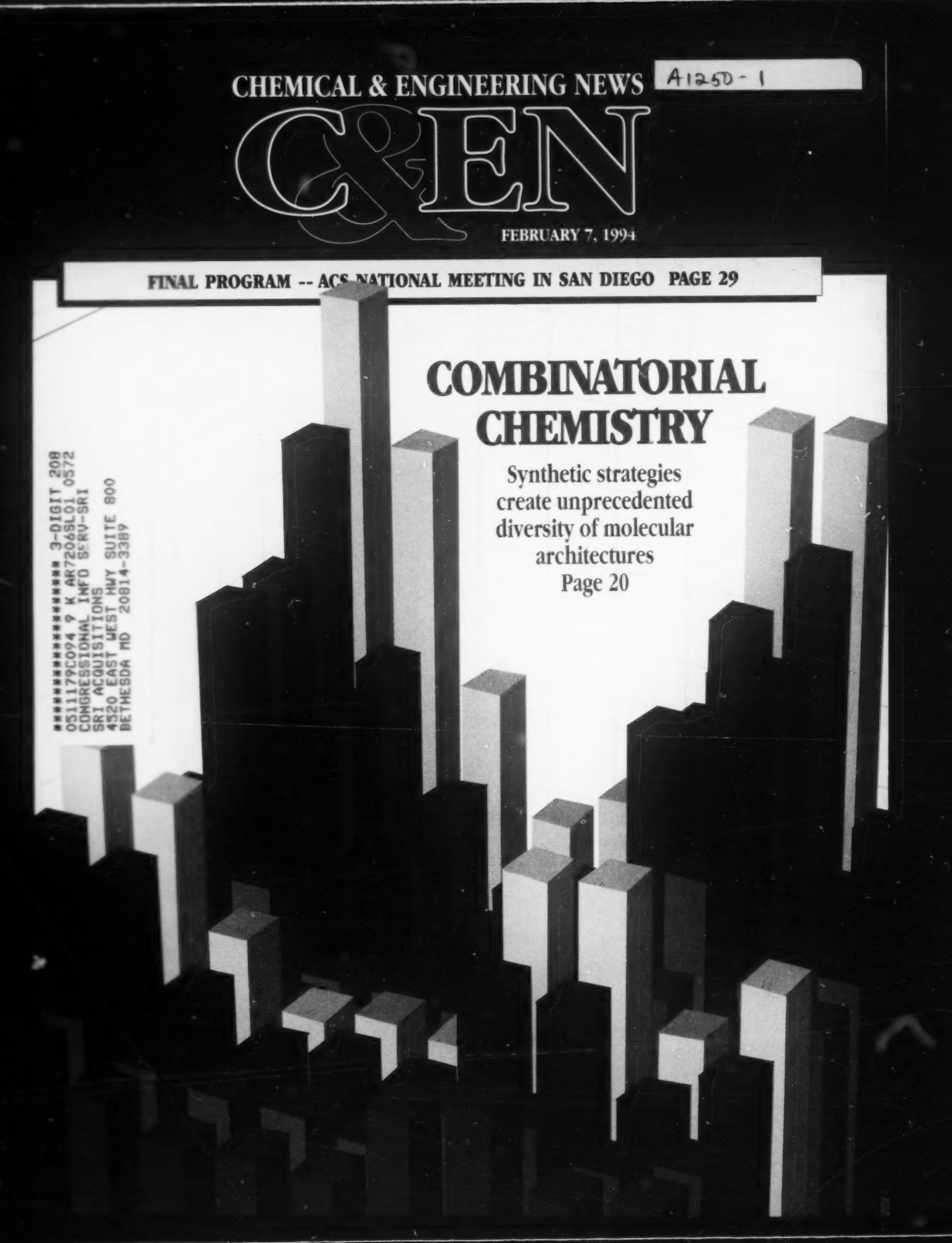
COMBINATORIAL CHEMISTRY

Synthetic strategies create unprecedented diversity of molecular architectures

Page 20



CHEMICAL & ENGINEERING NEWS

C&EN

FEBRUARY 7, 1994

NEWS OF THE WEEK

■ EPA unveils tough proposals for reauthorizing and revamping the Clean Water Act that call for development of a strategy to restrict or ban use of chlorine compounds; chemical industry reacts with outrage. **Page 4**

■ Modest electric fields can alter the structure of lipid monolayers that are models of biological membranes, suggesting a mechanism by which electromagnetic fields could affect biological systems. **Page 5**

■ Top U.S. researchers meet to help Clinton Administration write a national science policy. **Page 5**

■ Chemists in Tennessee synthesize single, highly symmetrical $C_{60}F_{48}$ fullerene isomer by direct fluorination of C_{60}. **Page 6**

■ Uncertainty over the Administration's health care reform plan is hurting the biotechnology industry by undermining investor confidence, says an industry survey. **Page 7**

■ Administration sends Congress proposal for Superfund renewal and revision; bill called a good first step by industry and environmental groups. **Page 7**

COVER: Detail from a graph of proteolysis data on substrates synthesized combinatorially on a silicon chip using technology developed by Affymax, Palo Alto, Calif.

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BUSINESS

Growing worldwide market for ethyleneamines will be served by fewer, but stronger, companies—led by Union Carbide, Dow Chemical, and units of Akzo and Nobel. **Page 11**

A life cycle study of detergent phosphates, conducted in the U.K., considers the cradle-to-grave environmental effects of phosphates and their replacements. **Page 13**

Business insights: The rate of inflation dipped below 3% in December—raising hopes, housing starts, and car sales. **Page 14**

GOVERNMENT

NSF advises chemists who want to receive federal funding to tie their research to national priorities and to direct more effort to strategic research areas. **Page 16**

Companies and organizations convicted of civil environmental crimes could pay increased fines if newly drafted penalty guidelines are approved by Congress. **Page 18**

SCIENCE/TECHNOLOGY

New strategy for designing organic molecules with nonlinear optical properties produces compounds that are unsurpassed at doubling the frequency of laser light passing through them. **Page 26**

FINAL PROGRAM

ACS national meeting in San Diego will offer attendees more than 5,700 paper presentations in 627 technical sessions, Sci-Mix, 43 ACS national award presentations, and a large exposition. **Page 29**

COVER STORY

Medicinal chemistry gets a boost as methods of combinatorial chemistry provide new ways of generating vast arrays of molecules that can be surveyed for biological activity. Page 20

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LETTERS

Chemists, chemical engineers

I always skim the names in the Letters to the Editor section for the authors and topics of these select missives. Imagine my surprise as a chemical engineer to see that my old friend Ted Logan, a surpassing chemist, was writing about chemists and chemical engineers (C&EN, Jan. 10, page 3). Imagine my pleasure when, having read his letter, it was clear that we had similar views and that he had also either forgiven or forgotten my youthful jibes at chemists when we worked together at Procter & Gamble in the 1960s.

There is only one point that I'd like to add to his thoughts. Chemical engineering, like all engineering, is an art—not a science. It is the art of the practical within the science of chemistry (and even biology and physics these days). Chemical engineers are well-trained artisans when they get their B.S. degrees and therefore are immediately useful to industry. B.S. chemists, on the other hand, are novice scientists and like most novices, are only prepared to learn more about their chosen field or other sciences. The narrowing differences in starting salaries that Logan reports for chemical engineers who remain in school to get M.S. and Ph.D. degrees are a measure of those engineers becoming engineering scientists and therefore more like Ph.D. chemists in outlook and in immediate value to industry.

If B.S. chemistry educations are changed to make chemists into artisans of immediate value to industry, we must face the inevitable fact that those who go on to get advanced chemistry degrees will no longer be novice scientists. That may be either good or bad, but it will certainly be true. It will change academic chemical research. The question is, can we afford the change just so chemists can move up the starting-salary table? I don't know the answer to that question, but it ought to be considered before we change the game plan.

Robert L. Morris
President
Managing Technology Inc.
Williamsburg, Va.

T. J. Logan perceives that the B.S. degree in chemical engineering is financially more valuable to new graduates than is the B.S. degree in chemistry. I agree. He suggests that we raise the market value of the chemistry degree by, in effect, making it a chemical engineering degree. I agree, but only to a point.

I suggest that rather than creating B.S. chemists in the mold of chemical engineers, we simply eliminate curricula leading to the B.S. degree in chemistry. All B.S. degrees in chemical science and technology would be in chemical engineering. They are more valuable to industry and of at least equal value to those going on for graduate work in chemistry. Of course, if all chemical B.S. degree recipients were engineers, their increased numbers would cause the employment market to devalue them too. We can deal with that if we ever come to it.

Donald J. Loundy
Carlsbad, Calif.

Safety regulations

Daniel J. Shanefield "hope[s] that [his] suspicion is wrong" in his letter concerning safety initiatives (C&EN, Jan. 10, page 2). I write to confirm his suspicion and correct his errors.

In the first place, to my personal knowledge, the private records of the chemical industry clearly show that the political movements that resulted in the variety of Occupational Safety & Health Administration (OSHA), Environmental Protection Agency, and other regulations we now have today also persuaded the Chemical Manufacturers Association (CMA) to generate its code of Responsible Care. That is, after many of the federal regulations were promulgated, the chemical industry then generated its own voluntary safety and environmental standards as a way to persuade Congress that additional laws and regulations would not be necessary to im-

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Smaller Group of Stronger Firms Vie For Growing Ethyleneamines Market

■ ***Union Carbide, Dow, and ethyleneamines units of Akzo and Nobel appear to be best positioned to meet increasing demand***

Susan J. Ainsworth, C&EN Houston

Unlike most chemical businesses, which have remained stagnant in the midst of recession, the ethyleneamines business has been reshaped by a number of major changes among producers over the past 12 months. These intermediate chemicals are used in a wide range of applications, including the manufacture of lubricating oil and fuel additives, chelants, polyamides, wet-strength resins, surfactants, fabric softeners, and bleach activators.

Just last month, Dow Chemical, the world's second largest ethyleneamines producer, started up its new 60 million-lb-per-year plant in Freeport, Tex. The plant, which will begin supplying outside customers within the next few weeks, boosts the company's total global capacity to 220 million lb per year. Only a year earlier, Union Carbide, the world's largest producer of ethyleneamines, expanded its capacity by 50 million lb per year at its Taft, La., plant, bringing annual capacity at the company's sole ethyleneamines production site to 230 million lb.

In a move that surprised the ethyleneamines market, in July 1993, Texaco Chemical announced its exit from the ethyleneamines business at year-end 1993, shutting down its unit at Conroe, Tex., and ending a toll production arrangement it had with Air Products & Chemicals.

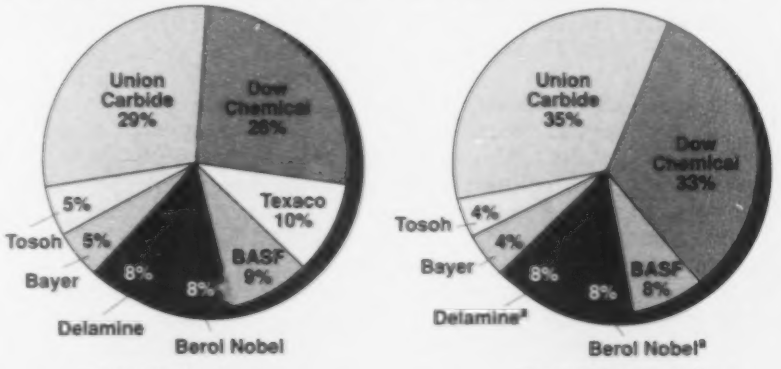
In November, Akzo N.V. and Nobel Industrier A.B. announced their intention to merge; that action is expected to be completed by the end of this month. This clears the way for the linkup between two European ethyleneamines players—Berol Nobel and Delamine, a joint venture formed in 1976 between Akzo Chemicals in the Netherlands and Tosoh Corp. in Japan. An Akzo spokesman says it's too early to tell if, following the merger, Berol Nobel and Delamine will cooperate simply as sister companies or will eventually merge to form one larger ethyleneamines entity.

As a result of these events, the market has become more consolidated, leaving fewer, but generally stronger players who are eager to capture additional market share. To be sure, "The ethyleneamines business has become an increasingly global business with fewer global players," Bert Kroese, general manager of Delamine, tells C&EN from the company's headquarters in Amersfoort, the Netherlands. Together, three producers—Union Carbide, Dow, and the potential partnership between Delamine and Berol Nobel—will control more than 70% of the global sales, he estimates. Ethyleneamines are priced such that transport all over the world is generally not a problem from a cost point of view, and "all three are marketing their products on all continents," adds Kroese.

Although the various changes in the market are adding up to a growing consolidation, it wasn't planned that way, according to Christer A. Andersson, president and chief executive officer of Berol Nobel, based in Stenungsund, Sweden. The potential joining of Berol Nobel and Delamine is merely a consequence of the Akzo and Nobel merger initiated for other reasons. And "the Texaco Chemical exit took place for profitability reasons," he adds. Indeed, Texaco Chemical president Ralph S. Cunningham says the "decision underscores the company's focus on profitable intermediate and specialty chemicals."

Certainly, the ethyleneamines market has not yet reached the stage of its life cycle where rationalization of capacity and reduction of the number of producers have been necessitated by weak growth. On the contrary, "despite the global recession's impact on the chemical industry, the ethyleneamines business is experiencing healthy growth," according to Robert S. Snyder, marketing manager for ethyleneamines at Dow in Midland, Mich. "The traditional ethyleneamine end-use applications have

Fewer producers share global ethyleneamines capacity



Note: Texaco exited market effective Dec. 31, 1993. **a** Delamine and Berol Nobel are expected to become sister companies this month. **Source:** Dow Chemical

weathered recessionary conditions. Dow projects global demand to grow at an annual rate of 4 to 5% through 1995."

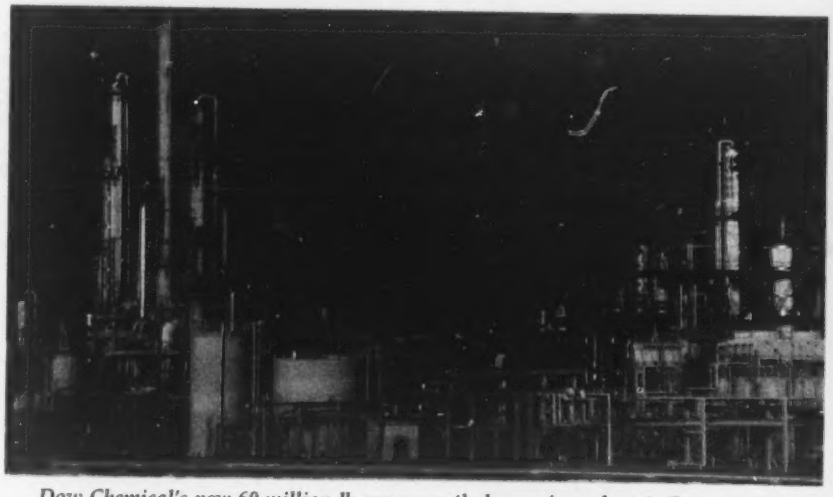
Most notably, future ethyleneamines growth will be fueled by more demanding environmental requirements for automotive lubrication oils and fuel additives under the Clean Air Act, says Snyder. In this end use, ethyleneamines such as diethylenetriamine (DETA) and polyethylene polyamine act as anticorrosives, performance enhancers, ashless dispersants, and detergent additives. In addition, demand for ethyleneamines, such as DETA, that go into wet-strength resins, will get a boost from the increased use of recycled paper in liner board, toweling, tissue, and sanitary products, he adds.

Snyder also expects to see above-average growth in demand for ethylenediamine (EDA), which is used in the bleach activator tetraacetylenediamine. EDA is well-suited for European laundry conditions where wash temperatures are warmer than in the U.S. Eric C. Rogers, product marketing manager for ethyleneamines at Union Carbide, adds that demand for ethylenediamine tetraacetic acid and diethylenetriamine pentaacetic acid, long used as chelating agents, is increasing in the paper industry.

Future market demand growth coupled with Texaco Chemical's exit from the market give producers of ethyleneamines that much more opportunity to expand their market share. Producers also hope the loss of a competitor will allow profit margins to strengthen. Prices for higher homologs have been under pressure since 1990, when Texaco Chemical expanded production, becoming a full-range supplier of ethyleneamines, observes Snyder. "Presumably, Texaco Chemical's exit removes some of that pressure and should help margins," he says.

Kroese agrees. Texaco Chemical took some business "from all producers in the late 1980s, so [its] exit will represent an opportunity for Delamine-Berol Nobel to recuperate from this loss and further improve its market position."

As Delamine and Berol Nobel become sister companies, they could form "a more powerful and competitive single entity, which will represent more than 20% of the market," according to Andersson. Although both companies have been operating on a global basis, Europe has been by far the most important market. As "a stronger competitor, we will look for larger stakes everywhere," including the U.S. market, says Andersson.



Dow Chemical's new 60 million-lb-per-year ethyleneamines plant in Freeport, Tex.

Supplying North American ethyleneamines customers isn't a problem for the two producers despite the fact that Delamine's plant is in Delfzijl, the Netherlands, and Berol's is in Stenungsund. In North America, Delamine has been selling ethyleneamines for more than 10 years through joint-venture parent Tosoh's Atlanta office, Kroese points out. Last year, Tosoh set up a pair of bulk storage tanks at Fairburn, Ga., and has been able to supply customers with Delamine-produced material even on short notice. In addition, Berol Nobel has been distributing ethyleneamines in North America since 1982 from terminals in Bayonne, N.J., says Andersson.

Pulling together the combined market share of Delamine and Berol Nobel gives the newly merged Akzo-Nobel company a "reasonable foothold" in North America, he says. "The U.S. market is growing, which means that the new joined company intends to grow as well."

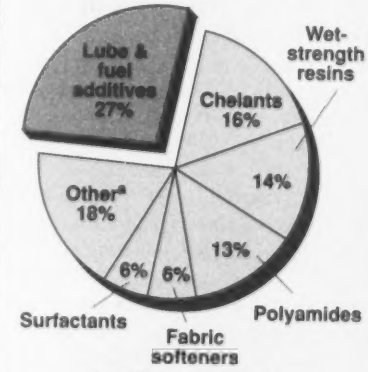
Through their parent companies' merger, Berol and Delamine could each gain access to another of the two commercial production routes to ethyleneamines, allowing them to favor the process that is most economical at a given time. Delamine's Delfzijl plant produces the full range of ethyleneamines (lower amines such as EDA as well as higher amines such as triethylenetetramine) using a process based on ethylene dichloride (EDC). Berol Nobel's plant employs an ethylene-oxide-based route that generates only lower amines.

Union Carbide is the only other world producer that has access to both routes to ethyleneamines. At Taft, units for both processors were upgraded in the expansion. Indeed, that expansion has been a "major step in our effort to strategically strengthen our ethyleneamines business," says Rogers.

The expansion has certainly helped Union Carbide "take advantage of the demise of Texaco Chemical's position in the market and pick up some of its business," adds Rogers. For its part, Union Carbide recently expanded its ethyleneamines product line to include anhydrous piperazine, a product that had been part of Texaco Chemical's ethyleneamines product portfolio.

Similarly, Dow Chemical's new Freeport plant is expected to give the compa-

Lube and fuel additives lead ethyleneamines use



1993 North American consumption = 200 million lb[b]

a Includes silicone derivatives, corrosion inhibitors, and phosphate mining chemicals. b Union Carbide estimate. **Source:** Dow Chemical

ny an edge in the market, allowing it more room for sales growth. Another advantage for Dow is its ability to supply "a full product line from multiple locations, which is important to our global customers," says Snyder. Dow has two plants in Freeport, with a combined capacity of 160 million lb per year, and a 60 million-lb-per-year plant at Terneuzen, the Netherlands, making it the only producer with world-scale manufacturing facilities in both the U.S. and Europe. "This flexibility enables us to accommodate the various homolog mixes demanded by our customers," he says.

Although Dow is "definitely trying to get our share of the market," Snyder says, "we have not rolled out any new programs or made any major marketing changes in response to the recent events in the market for ethyleneamines. Because we've been in the business for so long, we are in most of the established accounts and applications already and we have been doing business with many of Texaco Chemical's former customers all along." □

Detergent phosphates revisited in study

According to a new study, phosphate-free detergents are no better for the environment than those containing phosphates. Alternatives such as zeolites can do just as much harm to the environment. Furthermore, there may even be economic benefits to using phosphates, recovering them from wastewater, and recycling them. Those are among the major conclusions of "The Phosphates Report," just published by the Landbank Consultancy of London.

The study was funded jointly by the European Center for Phosphate Studies and Albright & Wilson, the British chemicals subsidiary of Tenneco, which is a producer of phosphates for detergents. However, the authors insist that they have been independent and objective. One of the authors, Bryn Jones, was a director of the environmental activist group Greenpeace in the U.K., and the other, Bob Wilson, formerly was a senior lecturer in statistics at what is now the University of the West of England, Bristol.

Phosphate builders for detergents have been an environmental concern for the past 20 years for their contribution to speeding up eutrophication—the excessive growth of algae and subsequent lowering of oxygen levels in rivers, lakes, and other waterways. As a result, governments in various regions in Europe and the U.S. have banned phosphates from detergents, requiring formulations with alternative performance-enhancing additives, although phosphates from other sources have not been controlled.

According to this study, however, "When assessed on a full cradle-to-grave basis, from the extraction of raw materials through processing, manufacture, use, and ultimate disposal, both zeolite and phosphate had an almost identical impact on the environment. Phosphates, however, have one enormous advantage over zeolites, and over all other detergent builders, in that they can be easily and cheaply recovered from wastewaters for recycling."

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